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telecom, and computers

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Why electronics execs are
just wild about Texas

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Who will survive the
shake-up in graphics boards?

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Electronic Business[®]

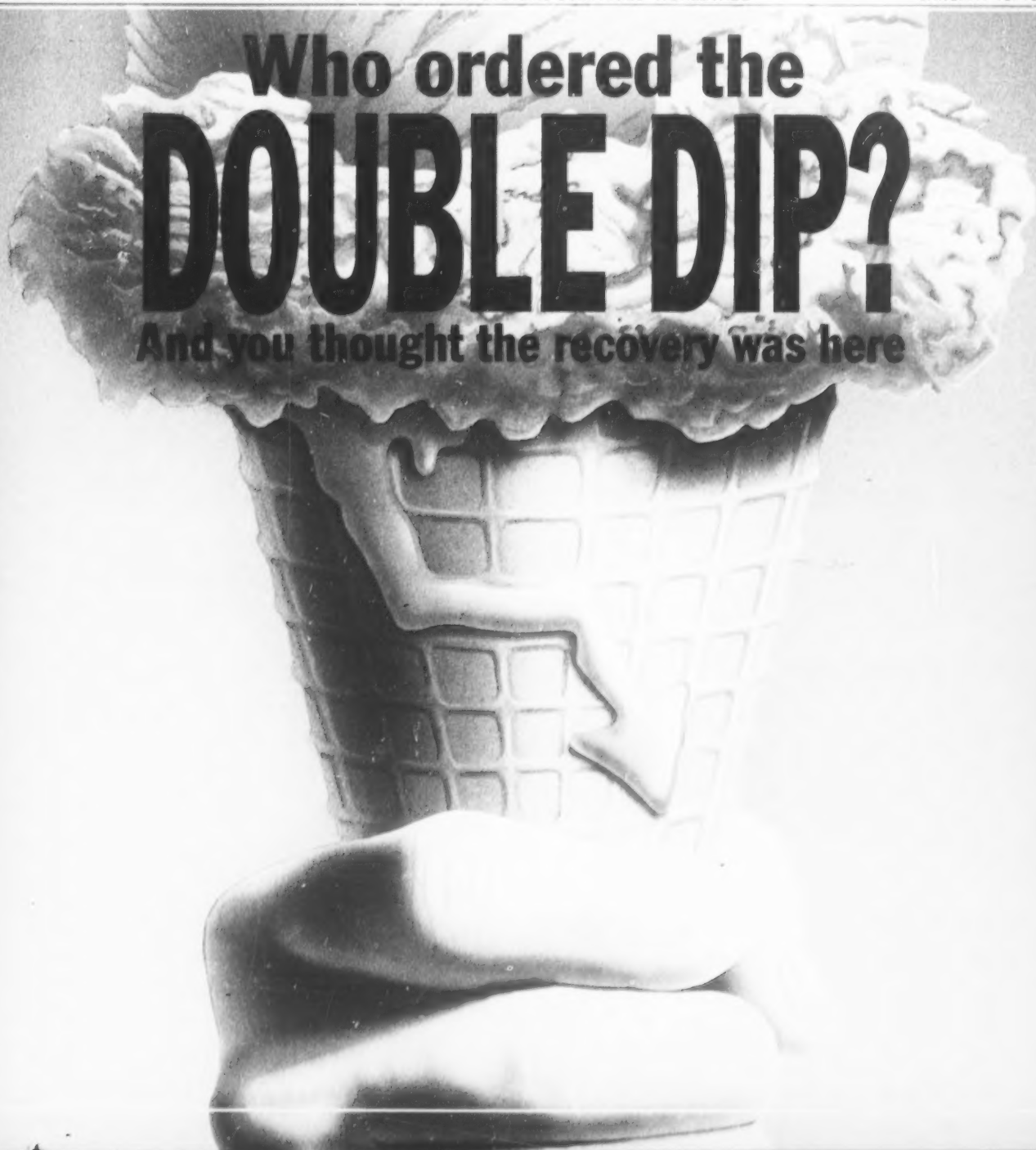
A CAHNERS PUBLICATION

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE

JANUARY 13, 1992

Who ordered the **DOUBLE DIP?**

And you thought the recovery was here



Electronic Business

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES—WORLDWIDE
VOLUME 18, NUMBER 1

JANUARY 13, 1992



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Even with government intervention, this year's lackluster recovery will hold electronics sales growth to a meager 5%. An anemic U.S. economy, faltering exports, a downsizing of domestic companies, and small businesses starved for cash will keep the industry in a slump. Says TI economist Vladi Catto: "I've never seen anything like it"

Cover illustration: Tom Sproumowski

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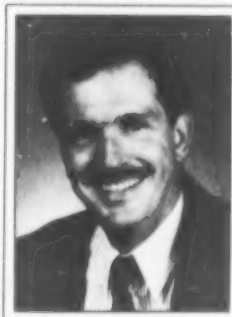
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INSIDE BUSINESS

Scouting markets in a shifting landscape



West Coast associate editor David Webb

WHEN WE began planning for this, our market outlook issue, it looked as though the headline would read something like: "What the recovery means to the electronics industry" or "Electronics opportunities in the new growth cycle." But reality seldom matches expectation. The questions that we found our-

selves asking about the recovery were not really "how much," but "when" and even "if."

As senior editor Elizabeth Baatz reports, the autumn decline in overall U.S. economic growth indexes occurred just as the rebound from the recession was expected to begin in earnest. The consensus among Elizabeth's circle of economists and industry sources: The recession is so atypical that the recovery from it will be equally hard to match with conventional models.

Such pervasive uncertainty increases the difficulty of market forecasting; but it also increases the value of careful and conscientious reporting and analysis. In these pages, our editors have given it their best shot, with in-depth looks at the likely future of computers, semiconductors, semiconductor-production equipment, passive components, and European and U.S. telecom-

munications.

Given the general nail-biting over our economy, these reports include some surprisingly positive news. For instance, assistant editor Barbara Jorgensen finds evidence that makers of passive components may see growth of at least 9% next year, a welcome relief from the past two years. Contributing editor Dwight

Davis reports that demand for networking products and systems accompanies the blurring of boundaries between data communications and telecommunications and, as a result, predicts enviable growth for producers of bridges, routers, and intelligent hubs.

Also in this issue, associate editor David Webb surveys the shifting landscape of the graphics board industry. The popularity of Windows applications, along with a host of rapidly emerging technologies, threatens to create a commodity market in VGA products that were not so long ago considered state-of-the-art.

It is not altogether clear how the changing economic landscape will affect the electronics industry. What is certain, however, is that the coming year will contain surprises for many companies and, probably, a new definition of prosperity.

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VBPA ARP

TRADE

Will Japan finally buy American?

FORGET THAT stuff about home being where the heart is. Home is where U.S.-based Japanese companies go when they want electronics suppliers—back to Japan.

According to the American Electronics Association, the tendency to freeze out U.S. suppliers is a big contributor to the U.S.-Japan trade deficit. Japan's Ministry of Trade and Industry (MITI) says, for the Japanese fiscal year ended March 31, 1989, the 156 Japanese electronics companies based in the U.S. sold \$16.2 billion worth of goods in the United States. But they bought only \$3.3 billion of their supplies from U.S. suppliers, while importing \$7.5 billion from Japan. Sourcing those supplies from U.S. manufacturers would make a prodigious dent in the

U.S. electronics industry's \$18.2 billion 1990 trade deficit with Japan.

Now, the AEA and its Japanese counterpart, the Electronic Industries Association of Japan (EIAJ), are trying to change the hearts and buying patterns of Japanese electronics companies that manufacture in the U.S. by promoting the thousands of U.S. electronics suppliers. That could mean \$7 billion or so in extra business for U.S. electronics companies, projects the AEA.

The AEA and EIAJ say they'll try to avoid the politics inherent in any U.S.-Japan dealings. They plan to target specific industries and contact the CEOs of leading companies in those segments as they create local procurement arrangements. The trade groups also established a Tokyo-based group called the "Support Committee to Promote Local Procurement in the U.S."

How effective the effort will be is yet unclear. Those kinds of overtures haven't worked in the past. "We're talking about behavior changes on both sides of the equation," says Bill Krist, AEA's vice president of international trade affairs. They're also talking about upheaval in established Japanese buying patterns.

Arm-twisting by European governments has been more successful in changing Japan's buying patterns there. According to the AEA, Japanese

electronics manufacturers in Europe buy 32% of their supplies locally, compared with only 23% local sourcing by their U.S.-based counterparts.

Local procurement by foreign-owned companies expands over time, Krist admits, "but the majority of Japanese companies haven't followed that trend." Despite the cost savings and service benefits associated with local suppliers, he adds, "When U.S. companies call on the Japanese, they often get the cold shoulder."

"More Japanese companies are moving to the U.S. and either purchasing U.S. companies or starting subsidiaries," explains Edward Koble, president of Raychem International in Menlo Park, Calif., chair of the AEA's Japanese trade group. "In instances where the Japanese have purchased a U.S. capital company, they've gradually stopped buying U.S. products and have purchased the products from Japan."

The Japanese need to change that practice, says Krist, but at the same time, U.S. companies need to be more aggressive. "U.S. companies have to recommit to being key suppliers and really go after the Japanese. We've got a Catch-22. We've got to break the circle," he says.

For more information, contact the AEA at (202) 682-9110 or the EIAJ at (212) 489-6270.

—Willie Schatz in Washington, D.C.



Jon McIntosh

INTERNATIONAL

Japan's MITI shifts funding from hardware to software

HERE'S THE BAD NEWS: the folks at Japan's Ministry of International Trade and Industry (MITI) are shifting their attention to software—long a Japanese weakness and a vigorous market for the United States. The good news is the MITI-funded software projects likely will include non-Japanese researchers.

MITI has invited non-Japanese to participate in projects before, but few joined because benefits from the na-

MITI funding shifting to software

(\$ millions)	Actual 1991 funding	Proposed 1992 funding
Open systems		
Develop open systems software	—	\$3.1
Evaluate software R&D environment	—	0.9
Promote OSI	0.2	0.3
Information technology		
Fifth-Generation computer	55.5	27.9
Fourth-Dimension computer	0.7	7.3
New software architecture	1.9	1.9
Regional development		
Regional computer systems	—	110.0
Support technical schools	1.1	1.1
Support regional software capabilities	0.5	0.5
Others		
Develop interfaces for the aged and health information filing	0.7	1.7
Measures against viruses	0.3	0.6
Survey graphic information mgmt.	—	0.1
Survey multimedia networks	—	0.1
Total		\$155.5

(Conversion rate: ¥130=\$1)

*Requested funding, subject to approval

Source: MITI

tionalistic programs seemed limited. But these latest projects have more potential. After years of outside pressure, MITI is aware that openness is in Japan's long-term interest. It also hopes to benefit from outsiders' general software know-how.

The projects target open systems and object-oriented programming that may help make up for Japan's deficiencies in software and are problems of interest to U.S. companies.

U.S. and European researchers are expected to get some of the development money and can pitch their proposals to the administering committee (once it's established) of the Information-technology Promotion Agency (IPA). AT&T has already been in to present its ideas to MITI.

Funding proposals include:

- A \$3 million proposal to develop a prototype software program that will allow applications software to run on different operating systems. Initial plans call for focusing on the different Unix operating systems, but the project may expand to other

systems as well;

- A project to develop a new software architecture, a kind of object-oriented programming, using modules that adapt themselves to changes in other parts of the program. SRI International joins Japanese researchers working with the IPA, and through SRI a number of European and U.S. university professors are working on the project;
- A \$1 million project to spur small Japanese software companies into productivity improvement by using development tools.

Hardware, meanwhile, hasn't been forgotten. Big money is still going to the Fifth Generation Computer project as it winds down, and to its successor, the Fourth Dimension or neural computer project.

—Paula Doe in Tokyo

EASTERN EUROPE

One-stop shopping for chips, passives—and kielbasa?

WAITING FOR AN invitation from Eastern Europe? The government of Poland has appointed an international consortium to advise foreign companies on how they can participate in the privatization of the Polish electronics industry.

The Polish government controls about 25 electronics companies that are larger than \$2 million in sales and produce passive and active components, semiconductors, and such finished goods as consumer electronics and telecommunications. The Bain-Moncrieff-Nomura consortium,

led by management consultants Bain & Co., will advise potential Polish and foreign investors on what's available to be privatized.

As an electronics market, Poland has some 40 million consumers, making it as large a market as Spain. Its currency is fully convertible, unlike other Eastern European currencies. As a possible manufacturing site, Poland is close to the European Community and has low labor costs and a high skill base, says Jean Baron-Mazloumian, a partner in Bain & Co. in Paris. For information, call him at 011-33-1-45057575; or fax 011-33-1-45051385.

—Barbara N. Berkman in London

STRATEGIES

Toshiba inches toward a U.S. manufacturing strategy

TOSHIBA CORP., long criticized for being the last major Japanese electronics company without a major U.S. manufacturing facility, finally is taking the build-where-you-sell message to heart.

Toshiba, the third-largest chip supplier to the North American market, still hasn't announced plans to build a full-fledged chip fab on American soil, as NEC most recently did. Instead, Toshiba has dipped its toe into U.S. manufacturing with a \$20 million-plus plant in San Jose to build high-capacity 3.5-inch disk drives. All products will be designed and engineered there, says Frank Buckley, VP of Toshiba America Information Systems. "Ours is the first fully integrated U.S. division of Toshiba, and upper management is watching us closely. I believe you will see this expanding to other parts of the company."

From a marketing standpoint, the move makes only marginal sense. Analysts wonder how Toshiba—never a force in merchant disk drives—will find a market for the 500,000 units it plans to build by 1993. Its first product, a 1-gigabyte drive, has already fallen behind a

BUSINESS TRENDS

pack that includes IBM, DEC, Hitachi, Quantum, Micropolis, and Seagate; once formatted, its drive reportedly runs at only 800-Mbytes.

Manufacturing in San Jose also means higher labor costs and fewer suppliers, since 90% of the world's drives are made in Singapore and Malaysia, notes Philip Devin, an analyst for Dataquest. Currently, only Quantum, Seagate, Hewlett-Packard, and DEC have any volume manufacturing of 3.5-inch drives in the U.S., he says.

Still, Toshiba stands to gain more than it loses. The move avoids exposing technology or disrupting established businesses while bringing Toshiba closer to workstation and high-end PC makers that use the drives—markets in which Toshiba has not competed in successfully to date.

—Peter Burrows

INTERNATIONAL

Europe's signals mixed on readiness for frame relay

IS EUROPE READY for frame relay? This emerging U.S.-invented technology's speed is a viable solution to Europe's expensive telecommunications costs and could ignite some datacommunications markets.

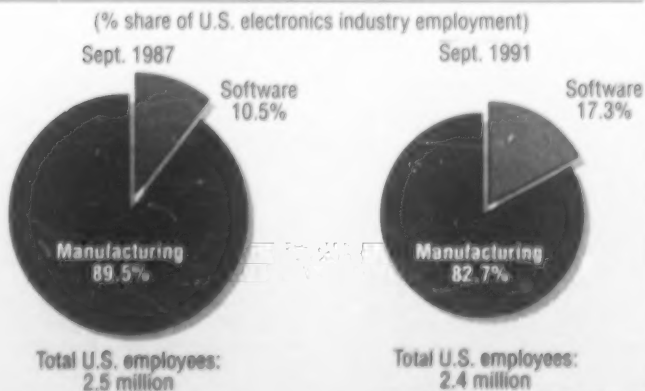
Frame relay is a transmission mechanism technology that accommodates high-speed transfer for data-intensive applications. That's important in Europe, where telecommunications is expensive.

For example, data sent through packet switching stops numerous times en route to its destination: frame relay is the express route. Proponents believe cost savings associated with frame relay's transmission speeds could unleash European demand for videoconferencing and large-file transfers of graphic, image, and CAD/CAM files—perfect applications for frame relay.

Two years of 50%-plus growth in Europe for other local area network interconnection products, such as

EMPLOYMENT

Software gets bigger piece of shrinking employment pie



Source: American Electronic Association

If the scholars and consultants haven't convinced you of the waning of U.S. hardware, take a look at employment trends. Software employees now account for 17.3% of the total U.S. electronics industry employment pie, up from 10.5% in the fall of 1987. Electronics manufacturers cut their employee rolls 2.8% on average over the last five years, while software houses increased employment at a compounded average annual rate of 12.2%. Thank goodness; otherwise the 90,000 jobs lost in the U.S. electronics sector from September 1987 to September 1991 would have been a lot higher.

—E. B. Baatz

bridges and routers, has convinced several U.S. companies that believe European demand for high-speed data networks will also fuel sales of frame relay services and equipment.

"Frame relay implementations are coming thick and fast from a large range of vendors," says Sean Phelan, an analyst with The Yankee Group Europe. These include BT Tymnet, U.S. Sprint, CompuServe, Nynex, GE Information Services, Hughes Network Systems, and Infonet. IBM expects a September 1992 launch of its European frame relay interface. U.S.-based Teradata will use British Telecom international frame relay for file transfer, accessing in-house e-mail and interaction of corporate databases.

Several obstacles to frame relay remain. Some countries don't yet have the digital link that frame

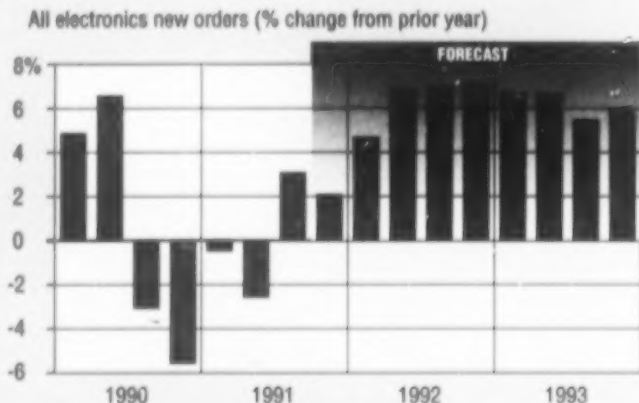
relay requires, and that may not change until Europe goes digital by the mid-1990s. So it would be difficult or impossible to offer pan-European service. Also, some potential customers worry that frame relay only checks for errors at each end of the transmission, while the slower but better established X.25 packet switch checks for errors along the way.

So far, it's been tough to quantify European demand. No sound frame relay market figures exist. Northern Telecom's European arm revised its 1991 market projections for frame relay twice so far.

Perhaps the biggest obstacle to frame relay use is that Europe has many small and midsize companies that can turn to the PTTs instead of private networks equipped with frame relay. Telecom Finland was

BUSINESS BAROMETER

Demand will climb slowly over next two years...



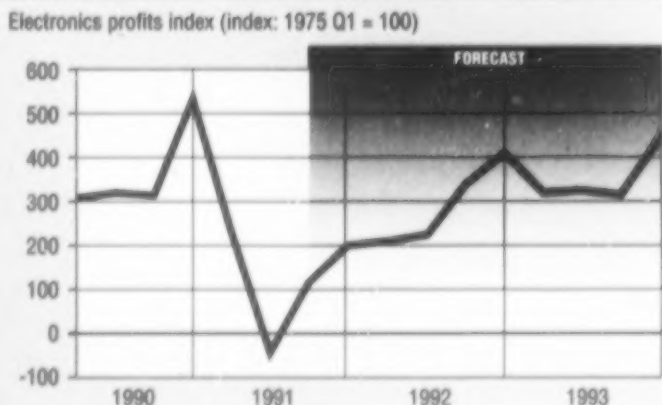
Source: Commerce Dept; forecast: Cahners Economics

...which will help electronics revenue to grow...



Source: ELECTRONIC BUSINESS; forecast: Cahners Economics

...and profits to begin to pull through in 1992



Source: ELECTRONIC BUSINESS; forecast: Cahners Economics

PROFITS

Profits improve but are still below normal

GUARDED OPTIMISM pervades the electronics industry as the ELECTRONIC BUSINESS Profits Index climbed out of the red, from -41.4 (index:1975:Q1=100) in the second quarter of 1991, to 116.6 in the third quarter. That's an improvement, but profits still remain far below industry norms.

The companies in the profits survey noted the recession had spread to both Europe and Japan, dampening foreign demand for their products. Some promising signs do exist, however, as orders for all electronic equipment rose 3.1% in the third quarter of 1990 compared with a year ago. Computer manufacturers are optimistic about sales of smaller network systems and PCs. Cahners Economics expects unit demand for computers to rise slowly through the first half of 1992 before gaining steam toward the end of the year as new product lines enter the market.

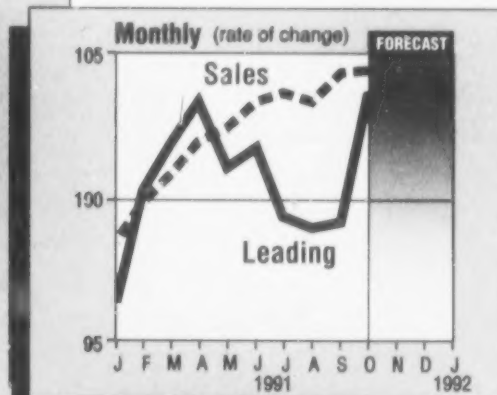
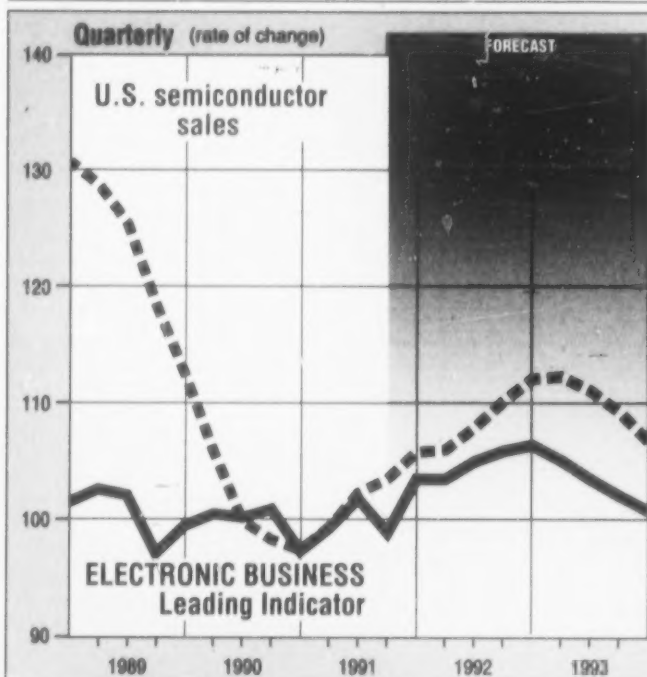
In terms of dollars and cents, the increase in unit demand is not expected to increase revenue substantially until 1993. The ELECTRONIC BUSINESS Revenue Index fell 0.7% during the summer quarter from the previous year, marking the second consecutive quarter of year-over-year declines—the first two-quarter revenue decline in more than 15 years. Expect revenue to increase just 3.3% in 1992 and 5.3% in 1993.

The profits dump has been even more severe than the recent revenue slide. While 1991 quarterly revenues on average held steady at 1990 levels, profits for the year fell back to 1976 levels. Restructuring costs continue to threaten profits this year but will begin to benefit the bottom line by the end of 1992 and provide a bigger payoff in 1993.

—John Farrell

BUSINESS BAROMETER

ELECTRONIC BUSINESS Leading Indicator

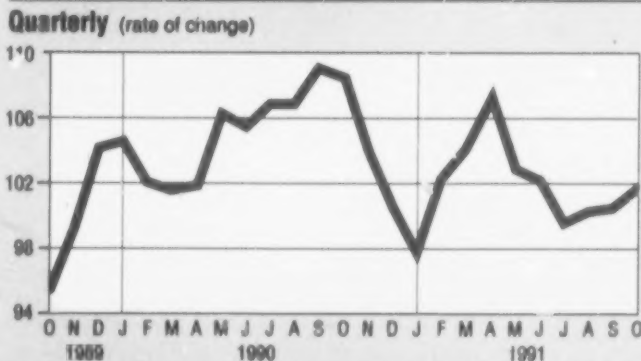


Indicator jumps up in October, finally

AFTER A DISAPPOINTING summer, the ELECTRONIC BUSINESS Leading Indicator (EBLI) rose strongly to 103.5 in October, from 99.1 in September. Most of the rise was due to increases in both the components lead time and the semiconductor stock price indexes. The most promising sign in October was provided by orders for semiconductors as its quarterly growth rose for the third consecutive month. The EBLI forecast calls for continued growth to a peak of 106.6 in December 1992, which means equipment markets won't hit peak growth rates until mid-1993.

—John Farrell

Semi bookings slowly head up from double dip



ELECTRONIC BUSINESS Leading Indicator (rate of change, Oct.)

	Latest month	Previous month	Year ago	1990 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, Oct.)	103.5	99.1	99.3	99.9
U.S. semiconductor bookings (\$ millions, 3-month average, Oct.)	\$1,252	\$1,205	\$1,210	\$1,254
Weekly hours of semiconductor production workers (monthly average, Sept.)	41.4	40.7	40.7	40.4
Electronic components lead time index (1977 = 100, Nov.)	103.2	89.9	80.5	80.7
S&P's semiconductor stock price index (1970 = 10, monthly average, Oct.)	63.4	66.4	52.0	64.6
Change in electronic components inventories (\$ millions, SA, Sept.)	-\$52	-\$75	\$50	\$33
Contracts and orders for plant and equipment (\$ billions, SA, Sept.)	\$33.6	\$34.2	\$38.5	\$39.6

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, Electronics Purchasing magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100.



COVER STORY

Shaky consumers and a timid Fed serve up a

DOUBLE

Electronics shipments are melting away
(annual % change)

9.1%
1988

5.4%
1989

3.8%
1990

1.7%
1991

Even with government intervention, this year's lackluster recovery will hold electronics sales growth to a meager 5%

Source: Commerce Dept.

Greg Dinderman

By E. B. Baatz

Forget the debate about whether the U.S. economy is in recovery or is stuck in a "double-dip" recession. For many U.S. electronics companies, the real issue this year will be a matter of mere survival. Overall, the U.S. electronics industry will have to scrape by with a sleepy 5% growth rate—a little better than last year, but only about half as strong as during the 1988 recovery and much less than during the 1984 boom.

DIP

Blame this year's anemic economic recovery. After an estimated 0.5% decline in inflation-adjusted gross national product (GNP) last year, **ELECTRONIC BUSINESS** pegs GNP growth at only 1.5% for 1992. (By comparison, GNP rebounded 6% in the first years following the 1974 and 1982 recessions.) The consensus of Robert Eggert's Blue Chip Economic Indicators panel, based in Sedona, Ariz., expects a measly 2.4% GNP growth this year. Their optimism has been slowly eroding: The 53 panelists recently lowered their collective forecast by three-tenths of a percentage point. "The economy has been stagnating since the second quarter of 1989," says Texas Instruments' chief economist Vladi Catto. "I've never seen anything like it."

Verifying the accuracy of any forecast will be especially tough this year; the federal government released a major revision to key economic data in December, which will almost surely alter everyone's GNP forecast (see "Government data revisions hide

multitude of sins," page 36).

No amount of fudging, though, will take the sting out of that 5% gain (unadjusted for price changes) in U.S. factory shipments of computers, communication equipment, components, and consumer electronics. Following growth rates of only 1.7% in 1991, 3.8% in 1990, and 5.4% in 1989, that will mean an unprecedented four-year lull for the industry. Not until after this year's elections—when all the attendant tinkering with the economy will have taken hold—will we see significant hiring, inventory restocking, and other sure signs of a rebound.

WHY HAS IT BEEN SO HARD to predict the timing of the 1992 recovery? One reason is that the current business cycle has been anything but typical; the "turning point" that economists usually seek has been hard to find. "It's been so long since we've been in a recovery that no one knows what to expect," says one corporate economist. "We're all waiting for a V-shaped or even a U-shaped recovery, but in fact we're seeing a saucer-shaped upturn." Adds Robert Collins, CEO of GE Fanuc Automation North America, "The fundamentals are so different than in the past, that no

The consensus forecast still predicts recovery

(annual percentage change)

	1991	1992
Real GNP	-0.3%	2.7%
Consumer prices	4.2	3.6
Personal income	-0.3	2.4
Industrial output	-1.6	4.0
Business investment	-3.6	2.9
Pretax profits	-1.7	13.4

(average for year)

Unemployment rate	6.7%	6.6%
3-month T-bill rate	5.6	5.5

Source: Blue Chip Economic Indicators

one knows what is going to get things going again."

True, turning points have always been notoriously elusive to forecasters. During the last economy-wide recession, most expected a lackluster 1983. When the recovery took hold, however, it was far from mild, especially in the booming electronics industry. But you don't need a crystal ball to see why 1992 looks so gloomy and why a repeat of the mid-1980s upsurge isn't likely:

- Consumers are broke. Household net worth fell in 1990 for the first time in two generations, so don't expect housing or autos to fuel a rebound;
- Small business is cash-starved. Start-ups are crippled by a severe credit crunch, and bank financing has been scarce. Even the Federal Reserve's aggressive lowering of interest rates last autumn failed to jump-start the economy;
- Massive corporate restructuring continues. In an attempt to re-position themselves for the '90s, big company execs are sweetening early-retirement deals or laying off employees in droves;
- The U.S. export boom is over. While the Mexican and Canadian economies may be coming up for air in 1992, Japan and Europe are due for economic slowdowns.

All of that leads Michael Evans of Evans Economics in Washington, D.C., to share the business community's dim outlook. "Businesspeople know more than we do," he says. "The economy has been in the dumps all year long, but the government statistics weren't showing it." Evans, the most pessimistic of the Blue Chip forecasting panelists, calls for just 0.8% GNP growth this year.

That could change if the sputtering consumer-spending engine were to rev up. Consider the big-

gest consumer purchase: the home. Because of an upheaval in banking and a decline in the rate of household formation, though, new housing starts won't rise much above 1.1 million units in 1992—a far cry from 1986's 1.8 million units. Although short-term rates dropped 3.5 percentage points from August 1990 to Octo-

ber 1991, housing starts fell more than 20%. "That has never happened before," says Evans. "So what is another half or full-point decline in the interest rate going to do? Not much. Most consumers are broke."

That's putting it mildly. Look at household net worth, which had been rising by an average of 8.3% every year since World War II. At that rate, households should have seen their net worth—pegged at \$17.3 trillion in early 1990—increase by \$1.4 trillion a year later.

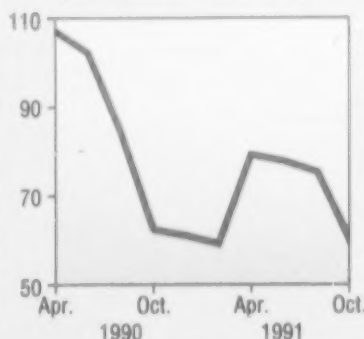
Instead, falling property values actually slashed net worth by \$181 billion—the first decline in two generations. As the *Wall Street Journal* noted recently, consumers are having to save money the old-fashioned way—by not spending their paychecks. That worries economists who are betting on a tax cut and lower interest rates to boost consumer spending. The slide in household net worth will be slowly self-correcting, but that won't help 1992 much.



"The economy has been stagnating since the second quarter of 1989, says TI's chief economist Vlad Catto

Consumer confidence is back in the dumps...

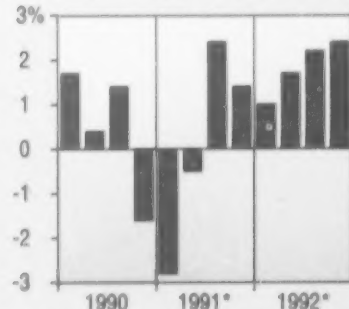
(confidence index 1985 = 100)



Source: The Conference Board

...which threatens GNP growth in 1992...

(% change from prior quarter, annual rate)



*Forecast begins 4th quarter 1991

Source: Commerce Dept./ELECTRONIC BUSINESS

Defining recessions and double dips

LIKE BASKIN ROBBINS'S 31 flavors, economists have phrases to describe all varieties of economic recessions. At the moment, the "double dip" seems to be on everybody's tongue.

The phrase was coined by a Ford administration official in 1975 and describes a period during which GNP grows for one or two quarters following a recession, then takes another downturn. In the past, double dips have been caused by inventory accumulation in anticipation of a recovery that doesn't materialize. After a quarter or two of inventory-led growth, the cuts that follow force GNP back down. Although unwanted inventory accumulation has not occurred this time, a double-dip recession is still possible—most likely because of low consumer and business confidence.

The official arbiter of when a recession ends and a recovery begins is the National Bureau of Economic Research (NBER), a non-profit think-tank in Cambridge, Mass. After poring over reams of complex statistics, the NBER's business-cycle dating committee decides on a recession's exact timing several months to a year or so after the fact.

While waiting for the NBER's decision, business economists resort to a generally satisfactory, off-the-cuff definition: If GNP declines for two or more consecutive quarters, a recession is presumed to have taken place. When GNP starts growing again, the recession is considered to be over. For now, the NBER hasn't decided about the 1991 recession, and economists will continue to argue and speculate about the double dip. □

If consumer spending (which accounts for two-thirds of GNP) can't rescue the economy, what about business spending? After a flat spending year in 1991, U.S. business will boost its computer purchases by 4.3% this year, predicts Maddy Franchi, senior economist with Cahners Economics in Newton, Mass. A delayed reaction to lower interest rates and growing need to replace old models will drive the investment. Still, Franchi notes, 4.3% growth means the fourth consecutive year of very slow gains. By comparison, computer spending by business rose 11% in 1988 and 21%

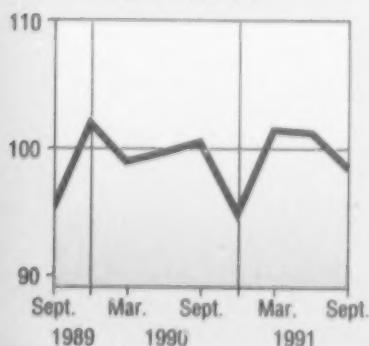
in 1984. Despite the fact that automation and modernization of existing factories remains an imperative for global competitiveness, the profit recession that has afflicted U.S. businesses ever since 1988 has put a straitjacket on investment spending.

Nor will inventory restocking add much fuel to the economic fires. In the first 24 months of the 1983-1984 recovery, inventory accumulation added \$87 billion to real GNP. Only half as much is likely in 1992 and 1993, which partly reflects a permanent change in corporate inventory policies.

Exports, one of the engines of the 1988 electronics industry surge, is running out of gas too. Japan's powerhouse economy, the number-two market for U.S. electronics exports, actually contracted in late 1991 and is expecting significantly slower growth this year. Germany, the number-four market, is headed for slower growth in 1992 as well. Canada and Great Britain, the number-one and number-three markets, respectively, for U.S. electronics, are expected to have stronger economies this

...and electronics leading indicator shows no hope...

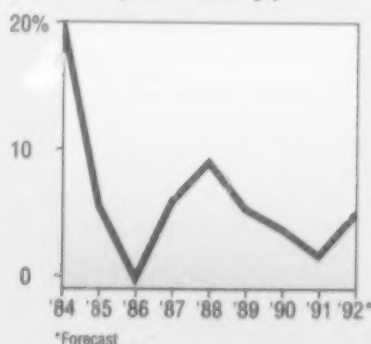
(rate of change)



Source: Cahners Economics/ELECTRONIC BUSINESS

...of much strength ahead for electronics shipments

(annual % change)



*Forecast

Source: Commerce Dept./ELECTRONIC BUSINESS

year, but they are slowly emerging from deep recessions the year before. For electronics, a slowdown in exports to Europe will shave a couple of percentage points off 1992 sales growth. "What else is there in the U.S. besides exports to drive an electronics industry recovery this year?" worries Todd Thibodeaux, research analyst for the Electronic Industries Association in Washington, D.C.

Federal or state government spending? Forget it. Even without a tax cut (and certainly with it), the federal deficit is likely to balloon in the next two years. That makes foreign in-

vestors nervous and keeps capital-starved domestic businesses at risk. As a result, federal spending, whether for electronic missiles or public works, will face stringent budgets for the next decade. The outlook isn't much better at the state level: About 40 state governments were running a deficit last year. In contrast to Washington, most state and local governments must by law cut spending and/or raise taxes to balance the books. Neither cutting spending nor raising taxes at the state and local government level are likely to stimulate the sluggish economy.

Government data revisions hide multitude of sins



ONE OF THE problems for economists trying to pinpoint economic growth in the year ahead is that history has just been rewritten. Last month,

the federal government extensively revised the nation's most important economic statistics: the national income and product account, which tracks GNP, exports, consumer spending, productivity, and other basic economic data. The revisions allowed the Commerce Department to fix old errors of under- or over-counting any particular sectors of the economy.

Among the changes was a re-basing of the inflation-adjusted GNP data from 1982 price levels to 1987 price levels. Because computer prices fell dramatically during those six years, last year's recession now appears to have been deeper than originally reported. As a result, any economic growth this year will seem proportionately stronger. Since the revision conveniently took place just before an election year, reports of economic growth in coming months will favor the incumbents.

The biggest change of all: The government's main economic measure of output of goods and services is no longer gross national product (GNP), but gross domestic product (GDP). The difference is that GDP includes output by all labor and equipment located inside the U.S., regardless of own-

ership. GNP includes output by all labor and equipment supplied by U.S. residents, regardless of where that property may be located. IBM computers made in Europe are thus included in GNP, but not in GDP.

There are three broad reasons for the new accounting:

- GDP is a more appropriate way to monitor short-term changes in the economy and better corresponds with employment, industrial production, and investment data;
- Most of the U.S.'s major trading partners have adopted GDP accounting, so international comparisons will now be easier;
- GDP figures should be more accurate

than GNP since government estimates of certain GDP components require less guesswork.

The changes offer both a challenge and an opportunity for forecasters. The challenge, says Richard O'Brien,

economist for Hewlett-Packard Co., is that "we must know where we have been before we can know where we are going." That's why the forecasts quoted in ELECTRONIC BUSINESS's annual outlook were especially tough to handle this year; the forecasts were all made before the GDP revisions had been announced. The opportunity is that once the data revisions have been absorbed by the economists, their subsequent forecast revisions can hide an assortment of new assumptions. As the cynics know, that means that forecasting errors in the 1992 outlook will be harder to pin down. □

**The main measure
of output is no longer
GNP but GDP**

Adding to the uncertainty are fears of a double-dip recession (see "Defining recessions and double dips," page 35). Several recent indicators suggest just that as positive economic signposts after the Gulf war took an unexpected U-turn last autumn. The Commerce Department's index of 11 leading indicators fell in September for the first time since January. Consumers' gains in real disposable income ground to a halt last summer. In the housing market, which had spurred a 25% increase in building permits earlier in the year, permits dropped again by autumn and a late-spring upturn in existing home sales had withered by September.

The electronics industry wasn't immune either. The ELECTRONIC BUSINESS Leading Indicator, a composite of six statistics, had risen from 95.6 in December 1990 to 103.3 by April 1991—not a big jump, but enough to suggest an electronics recovery was in the offing. By September, the indicator had fallen below 100 for the third month in a row. Semiconductor bookings, which had been growing 7% above

year-ago levels last spring, were flat again by autumn as well.

Whether the economy is officially on another downturn will be determined when fourth-quarter GNP data is released later this month. If the figures are gloomy enough, says TI's Catto, the Federal Reserve will cut interest

rates even deeper and increase the money-supply growth rate. But if the economy shows no clear signs of recession, then the Fed's too-little, too-late reactions could cause a repeat of last year's dismal performance.

Most economists think some type of government intervention is needed to get the economy back into high gear. "If the economy did not pick up in the fourth quarter—and I don't think it did—then Congress will come back in a state of panic this month," predicts Edward

Henderson, president of forecasting firm Henderson Ventures in Los Altos, Calif. Henderson figures that will translate into a tax cut that will boost consumer spending.

For most economists, however, human psychology is the wild card in predicting how government policy will impact the economy. "The only thing any of us agree is a positive sign is that next year is an election year and supposedly things are always good during an election year," says Jack Beedle, president of semiconductor forecasting firm In-Stat in Scottsdale, Ariz.

The biggest risk to these forecasts is that fiscal policy, in the form of a tax cut, and monetary policy, in the form of lower interest rates, may not jog the economy quickly enough or strongly enough. For now, the problem is that so few people seem to believe in the recovery. Robert Baer, manager of market intelligence at DuPont Electronics in Wilmington, Del., points to the company's current early-retirement plan—only the second in DuPont's history—and the fact that a friend was just laid off at Raytheon. "It just doesn't feel like a rebound," he says. □



The challenge, says Richard O'Brien, economist for Hewlett-Packard, is that "we must know where we have been before we can know where we are going"

Economists highlight key factors for the U.S. economy

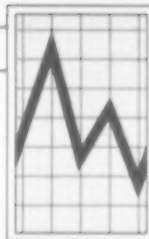
What are the most favorable factors?

- 74% said improvement in productivity
- 67% said lower, more stable inflation and interest rates
- 62% said export opportunities to Latin America, Europe, and the Pacific Rim
- 45% said higher savings rate, which will keep capital costs lower
- 31% said infrastructure rebuilding

What are the most unfavorable factors?

- 69% said slower labor force growth
- 62% said the debt overhang leftover from the 1980s
- 50% said higher taxes, especially state and local taxes
- 48% said mounting structural costs, such as health care and education
- 19% said global capital needs, especially in Eastern Europe

Source: Blue Chip Economic Indicators



Semiconductor vendors pray for 10% revenue growth

But 6% or 7% is more likely as the lingering recession, a surfeit of PCs, and a surge of competitors plague IC makers

By Teri Sprackland



Battered semiconductor manufacturers fear that 1992 could be another bust for the U.S. market. Sales growth is likely to stay stuck in the single digits for the third consecutive year, as overall U.S. sales grow to \$16 billion. Single-digit sales growth may be fine for the steel industry, but it's a near-disaster for the semiconductor industry.

Earlier forecasts for 1992, most in the 11% to 15% range, were based on two factors. Most economists predicted an end to this dip in the business cycle in 1991, and President Bush was expected to pressure the Federal Reserve Board to lower interest rates before his reelection bid. The first expectation didn't happen; the second one did, but declining interest rates did not end the slump.

Consequently, fourth-quarter sluggishness has prompted market research firms to hastily revise their forecasts. Estimates for overall U.S. semiconductor makers' sales growth hover in the 6% to 9% range. In-Stat Inc. in Scottsdale, Ariz., predicts 6.7% revenue growth, to \$16.1 billion. "The industry may have missed its

window for growth in 1992," says James Feldhan, In-Stat's senior vice president.

A surfeit of PCs is the big problem. As they remain unsold, orders for disk drives and other PC peripherals also plummet. "The hard-disk industry is in trouble because it ordered enough chips for 35 million drives in 1991, while only 28 million drives were needed," remarks Marcus Wilson, Intel's general manager of embedded microcomputers.

Even in categories where semiconductor vendor sales are expected to be strong—field programmable gate arrays (FPGAs), processors, and microcontrollers—the growing number of suppliers will depress prices and margins. "Pressure on margins is just the nature of business," because devices that were once proprietary now have multiple sources, notes Ray Farnham, president of National Semiconductor's communications and computing group in Santa Clara, Calif. "Welcome to the real world."

Not surprisingly, buyers love the oversupply. "Semi makers are fighting bloody wars over winning business," says Michael Loftus, vice president of marketing for E-Machines in Beaverton, Ore.

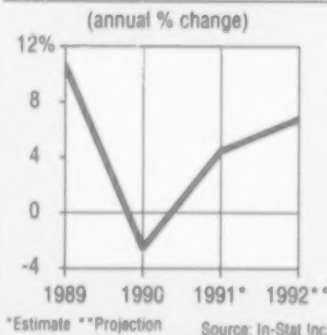
Here's a quick summary

U.S. semiconductor market

	(\$ billions)		%
	1991*	1992**	growth
Total revenues:	\$15.08	\$16.1	6.7%
Fast-growth segments:			
MPUs and MCUs	3.5	4.2	20%
MOS gate arrays	1.05	1.28	21%
Slow-growth segments:			
Bipolar	.81	.56	-31%
Memory	\$4.08	4.3	6%

Source: In-Stat Inc.

Overall market growth, 1989-1992



MARKET OUTLOOK

of expectations for the U.S. semiconductor market in 1992:

• **Processors.** Unit growth of the 80x86 microprocessor family will exactly match PC growth at 12.8%, according to In-Stat. The 386SX and higher devices will account for 95% of sales. The shift to more complex devices will increase total revenue 25%, to \$2.6 billion in 1992. Sales of eight-bit microcontrollers, still the largest controller market, will grow 22%, to nearly \$760 million in the United States this year, according to In-Stat. RISC devices will grow faster, at 60%, but will account for a relatively small market—around \$250 million.

• **Memory.** Revenue of the domestic memory makers will increase about 16%, to \$5.3 billion, according to the overly confident prediction of the Semiconductor Industry Association, including a 23% increase in DRAM sales. Industry officials are far less optimistic—stalled demand and new capacity for 4-Mbit DRAMs and delayed interest in the new 16-Mbit DRAMs will reduce overall memory tags by 30% this year, according to Kipp Bedard, vice president of Micron Technologies Corp. in Boise, Idaho.

• **ASICs.** Domestic revenue from gate arrays, programmable logic devices, standard cells, and other ASICs will jump 18% in 1992, to \$5.5 billion, according to Integrated Circuit Engineering Corp. in Scottsdale, Ariz. Standard cells and gate arrays will show the largest growth in 1992—more than 20%—while sales of full custom ASICs decline 4%, to \$1.1 billion.

Advanced technologies represent relatively small markets, but they have by far the largest growth potential. RISC chips have progressed from a specialty item for the workstation niche to a broader role as embedded controllers in laser printers, graphics accelerators, and other OEM gear.

The SPARC chip designed by Mountain View, Calif.-based Sun Microsystems Inc. led the RISC chip parade for CPUs with unit sales of close to 200,000 in 1990, according to In-Stat. This year SPARC should continue its lead over RISC chips such as the R6000 from MIPS Computer Systems Inc. in Sunnyvale, Calif. MIPS recorded 1990 unit sales of around

Key trends:

- 80x86 processor units up 13%, while revenue climbs 25%
- 4-Mbit memory chip prices may fall 30% due to overcapacity
- FRGA margins deteriorate due to influx of competitors

88,000 chips, says In-Stat.

Embedded applications of RISC chips are expected to boom over the next few years and spur total RISC chip revenue. The Acorn RISC microprocessor licensed by VLSI Technology Inc. in San Jose, which is typically

implemented as a standard cell with other functions, remains strong. It had 1990 sales of about 96,000. The 29000 from Advanced Micro Devices Inc. in Sunnyvale, Calif., is likely to gain market share as design wins turn into volume buys; its 1990 unit sales are estimated at 75,000. Intel shipped 43,000 units of its i960 RISC chip for embedded applications in 1990, but volume will soar this year, says Alan Steinberg, i960 marketing manager. "It will be one of Intel's highest growth areas."

Another technology market expected to soar are FPGAs, fueled by OEM buyers' demand for chips that speed their products to market. However, that growth has attracted additional vendors and will pressure prices, says John East, president and CEO of Actel Corp. In-Stat forecasts the worldwide FPGA market to increase 75% this year, to \$350 million.

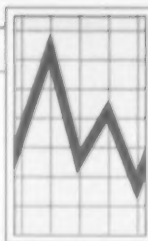
"FPGA competition is coming en masse from two directions—start-up companies and the conventional semiconductor establishment," notes Millard Phelps, an analyst with the investment banking firm Hambrecht and Quist

in San Francisco. New products will ship this year from at least three new FPGA vendors using the "antifuse" technology pioneered by Actel: Crosspoint Solutions, QuickLogic, and Concurrent Logic; industry giants such as AT&T, Motorola, and

NEC are also expected to join the FPGA battle. The influx of companies will deflate the relatively robust profit margins enjoyed by pioneers to date. "I'm looking forward to the commoditization of FPGAs like I'm looking forward to my next root canal," Actel's East says.

A bright spot is the interest in memory cards. Production will jump from 4 million units in 1991 to at least 52 million units this year, according to SRI International in Menlo Park, Calif. The SIA predicts that flash memory will be an \$800 million business worldwide by 1995, or about 3% of the memory market. □

**RISC chips have matured
from the workstation
niche to a broader role as
controllers in printers and
other OEM gear**



A bleak year for the computer industry

Sluggish sales, falling prices, and shifting buyer attitudes will probably limit revenue growth to 5% in 1992

By Rick Whiting



The computer industry begins 1992 in a mess. Prices and profit margins continue to plunge on desktop and portable computers. Sales channels are in upheaval. Vendors are restructuring and downsizing. Users are confused by the proliferating number of industry consortia, each claiming to have the technology of the future. And above the chaos hangs the recession that has kept potential buyers sitting on their wallets.

Although some companies saw feeble indications of an upturn during the third quarter of 1991, 14 of the largest manufacturers of computers and peripheral products, ranging from IBM to Seagate Technology Inc., saw average net profit on continuing operations decline by 72%. Most computer company managers are basing their 1992 plans on the assumption that there will be no real economic recovery until well into the year.

"Only the economists are saying that things are turning around," says Ken Olsen, president of Maynard, Mass.-based Digital Equipment Corp. "The only safe assumption is

that things will stay as they are or get worse." Toward the end of 1991, economists and trade groups that had been predicting computer industry growth of 8% to 9% this year were revising their forecasts down to the 5% range.

Even if business remains slow in 1992, analyst Sandy Gant of InfoCorp in Santa Clara, Calif., says computer companies may soon report higher profits for 1991 after trimming their bloated payrolls. John Logan, executive vice president of Boston-based market research and consulting firm Aberdeen Group Inc., expects a turnaround in sales in the second half of the year to push after-tax profits to the 5% range, up from their current 2% to 3%.

The sour economy is not creating the computer industry's woes, only exacerbating such problems as falling computer hardware prices, industry overcapacity, and shifts in customer buying patterns.

The broad price war within the PC industry that began in 1991 is likely to continue, given the availability of 80386 "work-alike" microprocessors, and the OS/2-Windows struggle between IBM and Microsoft Corp., predicts senior analyst William Bluestein of Forrester Research Inc. in Cambridge, Mass. Too

U.S. computer industry

(\$ billions)

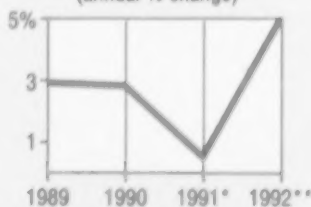
1991* 1992** growth

Total U.S. production:	\$56.5	\$59.3	5%
Fast-growth segments:			
PCs	24.7	26.7	8%
Workstations	6.8	8.1	19%
Slow-growth segments:			
Mainframes	3.8	3.7	-3%
Midrange	10.9	11.1	2%

Sources: Henderson Ventures, Dataquest, Data Analysis Group

Overall market growth, 1989-1992

(annual % change)



*Estimate **Projection

Source: Henderson Ventures, MIRC, BIS, Strategic Decisions, IDC

many products chasing too few customers will aggravate the financial squeeze. "We're in an overcapacity situation, in both the disk drive industry and the PC industry," says Finis Conner, chairman and chief executive of Conner Peripherals Inc. in San Jose. He foresees shakeouts and consolidation in both industries.

Before 1991, PC industry unit sales and dollar volume increased in lockstep. However, the final tally for the PC industry's 1991 performance will likely show that unit sales *increased* while dollar volume *decreased* due to falling prices, says Dataquest Inc. analyst Steve Lair. While he projects unit sales to grow around 5% this year, Lair predicts revenue to be even with 1991 "at best" and perhaps sink a few percentage points.

Street prices on notebook computers, which have plunged 22% in just 12 months, are symptomatic of the pricing and margin pressures being felt by PC makers going into 1992. "Price erosion will continue," Lair says.

Overall sales of desktop computers under \$12,000 will grow from \$58.6 billion in 1991 to \$65.2 billion this year, predicts market research firm BIS Strategic Decisions in Norwell, Mass. Traditional PCs will account for two-thirds of that revenue, workstations 18%,

Key trends:

- Decreasing profit margins on computer hardware
- Increased vendor emphasis on software and services
- Buyers moving toward client-server computing

and portables 15%.

Sales of midrange computers will remain lackluster as high-end PCs continue to eat into the traditional minicomputer market. Even sales of computers designed for client-server computing will not take off until more ro-

bust client-server software becomes readily available next year, says InfoCorp's Gant. "I'm not optimistic about the midrange market until 1993," she says.

One industry segment that will continue to grow is networking. Attempts by corporations to more efficiently move information among their PCs, mainframes, and midrange computers are boosting sales at companies such as Novell, which sells local area networking (LAN) software, and Cisco Systems, whose products are used to link LANs.

The software industry will also continue the rapid growth it has demonstrated in recent years. Spending for PC software was almost \$11 billion last year and will show a compounded average annual growth rate of 14% through 1995, estimates BIS vice president William Ablondi.

Major system vendors such as DEC now see software and services accounting for a majority of their sales in the future, and the revenue contribution from hardware is bound to continue declining this year. □

The hot computer technologies for '92

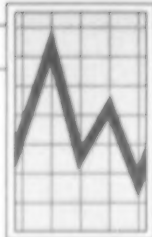
WHILE 1992 begins with the recession and its impact holding center stage for the computer industry, the new year promises its share of operating system wars, miniaturization, and other developments on the technology front.

Microsoft will debut its Windows NT operating system for PCs while IBM will counter with OS/2 2.0. More software based on object-oriented technology will emerge, BIS Strategic Decisions vice president William Ablondi says, while the first computers compliant with the ACE specifications should make an appearance.

RISC (reduced instruction set computer) will continue as one of the industry's fastest-growing technologies. Later this year, Digital Equipment will introduce its "Alpha" RISC-based line of VAX computers.

Although pen-based computers were trade show darlings last year, 1992 will be the first year that multiple vendors will begin shipping pen-based systems in volume. Industry watchers predict sales in the range of \$300 million. Sales of palmtop computers are also expected to accelerate to an estimated \$350 million this year.

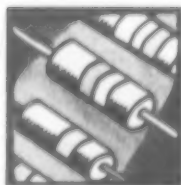
Expectations that the multimedia market—personal computers that combine audio, video, and imaging capabilities—is about to explode are reminiscent of predictions during the '80s of the always imminent "Year-of-the-LAN." "Where are the standards to make it work?" wonders one analyst. Mountain View, Calif.-based Market Intelligence Research Corp. predicts that multimedia will generate sales of \$1.35 billion this year. □



The end of the slide for passive components

Capacitors, resistors, other devices will show positive revenue growth for the first time in two years, but business is still lousy

By Barbara Jorgensen



In September San Francisco-based Electronic Outlook Corp. (EOC) predicted 9.2% domestic revenue growth in 1992 for the passives industry. EOC, considered the leading market research firm covering the component industry, predicted the increase based on a resurgence of orders from the automobile and personal computer industries and a firming of prices due to the continuing consolidation of the industry.

You're not alone if you think that was an overly optimistic outlook for the roughly \$12 billion merchant industry. In fact, EOC spent the better part of November scrambling to revise its forecast downward, to 7.8% growth, but industry insiders are even less sanguine. "I don't see the beginning of 1992 as any different from 1991," says Felix Zandman, CEO of \$446 million passives giant Vishay Intertechnology in Malvern, Pa. "The industry is in a recession." Historically, he adds, average resistor revenue growth was 3% to 4% per year—6% to 7% in a good year, and zero to minus in a bad one. Last year, he says, "was a

minus year." Overall, passives industry officials are more comfortable predicting 5% revenue growth for this year, at best.

Nevertheless, the author of the industry's most highly regarded forecast acknowledges that he is still optimistic about a recovery after two years of decline. "For 1992, I'm predicting a fairly strong positive, although some people

are not comfortable with that," says EOC president Ralph Anavy. He defends his forecast by noting that OEMs' inventories—and suppliers' lead times—are unusually low. If business improves and OEM orders pick up, as Anavy expects, passives makers' excess capacity would shrink and lead times stretch. Faced with tightening supply sources, OEMs would cushion themselves by adding inventory.

Even if increased demand does not materialize, market seers insist that industry consolidation will firm prices across the board in 1992 due to the ongoing consolidation of the components makers. Vishay, which has already successfully folded Dale Electronics' and Corning's resistor operations (among others) under its already ample umbrella, announced in September a bid for Sprague's solid-tantalum capacitor and

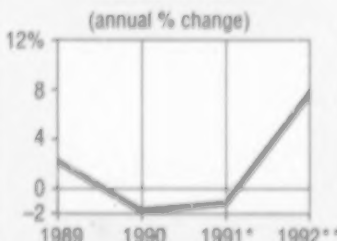
U.S. merchant passives market

	(\$ billions)		%
	1991*	1992*	growth
Total revenue ¹ :	\$11.5	\$12.4	8%
Fast-growth segments:			
PWBs	3.3	3.6	10%
Relays	0.7	0.8	8%
Slow-growth segments:			
Capacitors	2.0	2.1	6%
Resistors	0.9	1.0	6%

¹Includes connectors, PWBs, capacitors, resistors, switches, and relays.

Source: Electronic Outlook Corp.

Overall market growth, 1989-1992*



*Estimate

**Projection

Source: Electronic Outlook Corp.

thick-film network divisions. As domestic competition decreases, passives market share leaders such as AVX Corp. in Myrtle Beach, S.C., and Vishay are expected to be

less aggressive on price and more conscious of the bottom line, Anavy maintains.

Another prop for prices is reduced capacity in some sectors as the consolidation leads to factory shut-downs. Connector maker Augat Inc. in Mansfield, Mass., closed several interconnect plants in November.

Slim profit margins—3% to 5% after tax—also will prompt passives players to raise prices, says Anavy. "Companies are squeezed for profits," he asserts, and he predicts that price increases are coming. Passives makers flatly disagree. "I wish it were so," says a senior official at one passives manufacturer. "Unit growth is definitely going to outpace dollar growth." Indeed, prices for dipped solid-tantalum caps dropped by about 20% last year, according to polls by *Electronics Purchasing* magazine. In addition, attempts by connector makers last spring to boost prices by a mere 2% to 3% failed. Buyers claim that hikes were unsuccessful, as list prices bore small resemblance to purchase prices.

The same price pressure is true for resistors. "I see prices eroding," says Vishay's Zandman, "but not worse than any other year. Prices erode on an average of 3% per year."

The passives industry's price and profits squeeze is due, in part, to a crucial technology shift, in addition to the effects of the recession. Passives makers have spent heavily in response to OEM demands to develop smaller, surface-mountable (SM) components and are eager to recoup their investment.

In addition, passives makers also had to invest in quality-improvement programs to stay in the game. Ford Motor Co. in Dearborn, Mich., is paring its supplier list to companies that can meet its five-parts-per million failure rate and have global manufacturing capabilities, according to Frank Donovan, supervisor for discrete components purchasing.

Demand for smaller component sizes and SM devices is tremendous. A few manufacturers report that orders are growing 20% to 30% a

Key trends:

- Industry consolidation
- Conversion to surface mount
- Miniaturization

year in certain SM product lines. Surface mount, or boards using both SM and leaded components technology, will be used for in-house assembly operations 73% of the time by 1995,

up from 52% in 1990, according to Berkeley, Calif.-based Technology Forecasters.

Most of the growth in consumption of passives will be in the Far East, thanks in part to the area's early push to SM technology. EOC's Anavy forecasts 40% of the \$11 billion world capacitor demand will originate in the Far East by 1995. "The Far East is the fastest-growing market in the world," he says. "U.S. companies must be more aggressive in their efforts to establish themselves in the Far East."

Breaking into the Far East is getting tougher. "It's not too late to get into these markets, but it's more difficult because the long-term players have already established themselves," notes Allan Cole, AVX vice president of sales. "It's tough for newcomers to displace them."

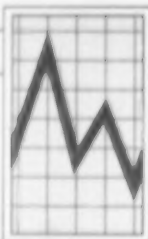
For now, at least, about 25% of the world's capacitor demand is in the United States. Although the Electronic Industries Association estimates ceramic capacitors account for roughly 45% of U.S. capacitor sales, manufacturers report increasing interest from OEMs in tantalum capacitors because they are reliable and stable, despite the price premium relative to ceramic caps. Capacitor sales

growth of about 6% is predicted this year for a merchant market of \$2 billion, but some players are more optimistic. In fact, 15% growth in capacitors is not inappropriate, claims Dick Knerr, Murata Erie North America's director of market research. Knerr and

other optimists are counting on strong growth in automotive, telecom, and computer markets to propel capacitor sales.

As for resistors, EOC calls for 5.6% revenue growth in 1992, producing a merchant market of \$1 billion. Industry consolidation, not technology, is having the biggest impact on the resistor market. Vishay has captured an estimated 50% of the U.S. market since 1986 and about 30% of the European market. There's no indication that the acquisitive Vishay, or the overall industry consolidation, will slow anytime soon. □

**A few manufacturers
report orders are
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year for certain surface
mount products**



Factory automation's three-year price war

Customers' overcapacity and a soft economy pinched sales of electronics assembly gear last year. Few suppliers see relief in 1992

By Peter Burrows



Despite headlines about U.S. companies' unwillingness to invest in capital goods, there is a world-class glut of modern production capacity in electronics factories. Competitive pressures on pricing, quality, and efficiency—not to mention the rising complexity and density of PCBs—compelled electronics manufacturers to fill their factories with pick-and-place machines, robots, and other types of equipment to satisfy the market demands of the late 1980s. To no one's surprise, customers' overcapacity set off a painful price war between automation vendors when the economy headed south two years ago. "1990 and 1991 have been terrible years," says Charles-Henri Mangin, president of the market-research firm Ceeris International in Old Lyme, Conn.

Prices have dropped more than 15% for the industry during the past two years, according to Mangin, although new products boast performance that dwarfs their predecessors. Overall unit sales remained flat, but the pricing pressure trimmed revenue from \$535 million in 1989 to \$500 million in 1991.

Mangin says the market will rebound to \$550 million this year if the economy turns around, but most vendors are planning for the worst. "We don't expect any substantial pick-up in 1992," says Ronald Titlebaum, president of Dynapert Inc. in Beverly, Mass. "We're stuck in the capital-spending doldrums, and there's already a lot of excess capacity and used machinery kicking around."

Even the heady market for surface-mount technology (SMT) assembly equipment has felt the chill. The \$250 million-plus market for SMT pick-and-place systems bounced along at 30%-plus annual growth during the 1980s as SMT devices began to replace their through-hole predecessors. In 1990 the market dropped by 15%, and has remained the same during 1991, Mangin says.

Given those circumstances, the 1992 goal for most automation vendors is to steal—or at best maintain—market share now and look for profits later. Heavy discounting should continue in most markets, and companies will rely on new products to keep them apace of the competition. "It may be a down year, but we plan to steal 5% to 8% of the market through new products," vows Bill Emery, assistant general manager

U.S. factory automation market

(\$ millions)

1991 1992* growth

Total revenues: \$500 \$550 9%

Fast-growth segments:

Aqueous cleaners
High-speed SMT pick-and-place

Slow-growth segments:

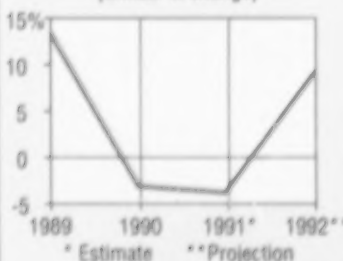
CFC-based cleaners
Through-hole pick-and-place

*revenue breakdown not available

Source: Ceeris International Inc.

Overall market growth, 1989-1992

(annual % change)



* Estimate ** Projection

Source: Ceeris International Inc.

MARKET OUTLOOK

of Panasonic Factory Automation in Franklin Park, Ill. Panasonic is expanding into new areas such as laser-based inspection and mechanical robots. Market-leader Fuji America, and Sierra Research & Technology, will introduce machines for placement of tape-automated bonding (TAB) devices.

Fuji and Panasonic dominate the high-end of the automation market with highly-integrated turnkey production lines for customers that need both high-throughput and high-performance. These \$1 million-plus systems, which often are used as corporatewide SMT job-shops by large electronics manufacturers, can accurately place as many as 24,000 fine-pitch devices per hour, says Mangin. Dynapert, Universal, and Quad Systems also compete at the high-end of the market.

Competitors in less technology-driven strata of the market also are developing broader solutions. They are driving prices down, rather than up, in an attempt to expand unit sales. Vendors, such as Philips Industrial Automation and Zevatech, offer entry-level SMT production cells consisting of a screen-printer, a placement machine, and a solder oven, for around \$100,000.

These mini-production lines are the keystone to the vendors' cellular strategy for more volume. Customers are urged to buy multiple copies of the cells and dedicate each one to a specific product. This offers customers closer control over manufacturing processes and fast response when orders arrive, but without the huge cost-per-board incurred with a high-end system. "With prices dropping, the yardstick becomes manufacturing efficiency, not equipment utilization," explains Robin Alan Rhodes, manager of SMT Assembly Systems for Philips. "You don't have to run the line three shifts a day at 13,000 devices per hour to amortize the price tag." Rhodes says Philips enjoyed 15% growth to about \$50 million in U.S. sales last year, with sales of these low-end systems providing more than half of the growth.

Still, the fastest-growing automation markets are those that offer answers to technical problems as well as added productivity gains. The need for speedy and accurate robots to

Key trends:

- Continued heavy discounting due to weak demand
- \$100,000 production cells gaining popularity
- Aqueous cleaners replace moribund CFC-based systems

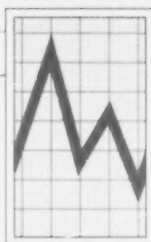
keep up with the increasing density of boards enabled Lawrenceville, N.J.-based Megamation Inc. to increase orders by 300% in the past year. The \$3 million company sells lightweight, small footprint cells that squeeze four independent robot arms into one mechanism, says vice president of marketing Joe Schneider. Four Megamation cells recently replaced 43 robots at Northern Telecom in Research Triangle Park, N.C., and they are setting a fast pace at the factory. "The only problem is that we're still using older [assembly line] feeders, and the Megamations are just wearing them out," notes an NT source.

FOR COMPETITORS WITHOUT such a compelling market driver, the name of the game will continue to be integration. Customers are pushing vendors to provide the peripherals, systems software, and human interfaces necessary to make their production lines more flexible and controllable. "The trend is to get more productivity out of the investment by giving operators more of a chance to interface directly with the equipment," says Robert Collins, CEO of programmable logic controller-maker GE Fanuc Automation North America Inc. in Charlottesville, N.C. Like many other automation vendors, GE Fanuc has added a computer and graphics monitor to new products to meet that need.

The ultimate goal? To give supervisors or operators the ability to control and adjust equipment at any place on the production line from a PC or workstation running factory management software.

The trend toward computer-integrated manufacturing is opening up lucrative markets for both software and hardware. Analysts say the market for factory-management software is growing more than 30% a year. Sales of single-board computers and graphics-equipped controllers are growing 14.5% per year, according to Automation Research Corp. in Medfield, Mass. Market Intelligence Research Corp. in Mountain View, Calif., predicts that sales of PCs and workstations into the automation market will grow 10.1% per year between 1989 and 1996, to \$8.2 billion. □

The 1992 goal for automation vendors is to steal—or at best maintain—market share now and look for profits later



Telecom/datacom vendors gear up for 10% market growth this year

Routers, FDDI, intelligent hubs will pace networking market as frame relay transmission boosts wide area telecom speeds

By Dwight B. Davis



Overall, the U.S. telecommunications/data communications marketplace should see continued, albeit moderate, growth this year. Select areas in both the local and wide area segments of

the business, however, are expected to post gains that other electronics markets will be hard-pressed to match: Even in tough economic times, companies must continue, and possibly increase, their use of networks and communications products.

The North American Telecommunications Association (NATA) pegged the 1990 U.S. market at \$35.2 billion in its mid-year 1991 survey of the major telecom equipment markets. At the time, NATA projected that the market would reach \$38.4 billion in 1991 and \$42.2 billion this year—an annual growth rate of just under 10%. The NATA figures include everything from phone company switches to facsimile machines to local area network (LAN) equipment (see table).

Another trend to watch: Distinctions between the phone-based telecom world and the computer-oriented datacom world will continue to blur. One

of the hottest growth areas, in fact, will be that of internetworking equipment, which sits at the boundary between LANs and wide area networks (WANs). As LANs have proliferated, the need to transmit data between nearby and distant networks has become acute.

Routers, the premier internetworking devices, must interface with LAN protocols and media on one side and WANs and transmission schemes on the other. In 1990, 11,352 routers, with a total value of \$147 million, were shipped in the U.S., estimates Dataquest Inc. This year the market will grow to 26,748 units valued at \$286 million.

Router supplier Cisco Systems Inc., which accounted for 36.2% of the 1990 market, should continue to dominate the sector, says Dataquest analyst Marty Palka. Other leading vendors include Digital Equipment, Proteon, Wellfleet, 3Com, and Advanced Computer Communications.

On the LAN front, intelligent hubs will continue to multiply, functioning as central wiring devices with communications spokes radiating out to individual networked devices. Most hubs support various LAN technologies, such as Eth-

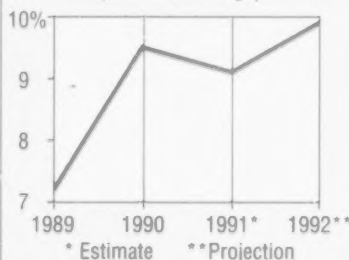
U.S. telecom market

	1991*	1992**	% growth
(\$ billions)			
Total revenues:	\$38.4	\$42.2	10%
Fast-growth segments: (\$ millions)			
Routers	212	286	35%
Intelligent hubs	544	716	32%
Slow-growth segments: (\$ millions)			
LAN equipment	2,210	2,251	2%
Modems	2,785	2,850	2%

Sources: North American Telecommunications Assn.; Dataquest

Overall market growth, 1989-1992

(annual % change)



* Estimate ** Projection
Source: North American Telecommunications Assn.

ernet, token-ring, and the Fiber Distributed Data Interface (FDDI). They can also house devices such as routers and bridges to link the LANs to campus-wide backbone networks or to WANs.

Last fall, leading hub vendor SynOptics Communications Inc. cut the prices of its 10Base-T Ethernet systems, which should further spur the already brisk market, Palka says. In 1990, the U.S. market for intelligent hubs stood at \$381 million, and the shipped devices supported 1.2 million communications ports, according to Dataquest. The market will grow to \$716 million this year and will comprise 2.7 million ports.

THIS YEAR SHOULD ALSO SEE the fruition of the 100-megabit-per-second (Mbps) FDDI networking protocol, analysts agree. This month, Crescendo Communications will ship the first FDDI devices designed to run over unshielded twisted pair copper wiring. The price cuts permitted by this non-fiber design, combined with lower-cost fiber-based adapters from Sun Microsystems and others, will make FDDI links to desktop computers economically feasible for many advanced workstation applications. As a result, Dataquest predicts shipments of network interface cards pegged to such workgroup-oriented FDDI networks will rise from a mere 2,113 in 1990 to 43,000 this year.

For FDDI devices of all types—including those connecting desktop devices, host computers, and LANs to LANs—the worldwide marketplace totaled \$97 million in 1990, according to market research firm Infonetics Research Inc. This year, the worldwide market will explode to \$470 million, the company projects.

FDDI's 100-Mbps speed is of little value in connecting LANs and the much slower WANs. In the WAN world, modems that send data at 19.2 kilobits per second (Kbps) are considered fast, and public data transmission services have topped the 56-Kbps range. Developments are underway to help WANs meet the LANs' internetworking requirements.

Key trends:

- Internetworking equipment will blur the lines between telecom and datacom
- Vendors will use ordinary copper wiring as well as fiber to send data at very high speeds
- Wide area network transmission will be enhanced with frame-relay and Sonet technology

This year, the most visible of the WAN innovations will be a transmission technique called frame relay. A data service that sends individually addressed packets of data to the proper destinations, frame relay has been embraced by public data networks as well as router and other equipment suppliers. After an initial uncertainty, even

the Bell Operating Companies are moving to offer the service over their networks.

As a result, a growing number of frame-relay options will appear this year. Most equipment that offers frame relay, and most public carriers that offer it as a service, run the packets at the so-called "T-1" rate of 1.5 Mbps or slower. But frame relay can operate at higher speeds; Cisco Systems, for one, has demonstrated routers running the technology at 45 Mbps.

Last year, its first on the market, frame-relay equipment and services accounted for just \$8 million in sales worldwide, says Infonetics president Michael Howard. By 1993, he estimates, the market will grow to \$213 million.

A data-transmission service called Switched Multimegabit Data Service (SMDS) will offer speeds up to 155 Mbps but won't be universally available before 1995, analysts believe. Even higher data rates will be possible once the public carriers implement a fiber optic transmission technology called Sonet (Synchronous Optical Network).

With a basic transmission rate of 51.84 Mbps and a maximum rate of 2.48 gigabits per second, Sonet-based facilities could support demanding computer networking needs.

Few analysts expect Sonet to be widely installed until the mid-1990s, but Santanu Das, president and CEO of TranSwitch Corp., predicts that the technology will arrive faster than that. TranSwitch designs Sonet integrated circuits and other high-speed communications chips. "Systems vendors are under tremendous pressure from the carriers to provide them with Sonet equipment," Das says. While he agrees that Sonet may not be available worldwide until 1995-96, he says, Sonet "islands" will be available this year for limited-distance, high-speed communications. □

The proliferation of local area networks has led to an acute need for new systems to transmit data between nearby and distant sites

Europe's cellular networks ring bells for U.S. vendors

New competition from the private sector will help boost the number of cellular subscribers by 63% during the next two years

By Barbara N. Berkman

The deregulation of Europe's state-controlled telecom authorities (the "PTTs"), the opening of the former Soviet bloc, and an explosion in cellular networks have fueled a boom in European telecom equipment orders that shows few signs of cooling down in the next 18 months.

As European governments authorize new mobile networks to compete with those networks run by their PTTs, cellular communications

shapes up as the hottest European market opportunity for U.S. telecom equipment companies. The number of Western European cellular subscribers is expected to rise from 4.6 million in 1991 to 6 million subscribers this year and 7.5 million in 1993, according to BIS Strategic Decisions in Luton, England.

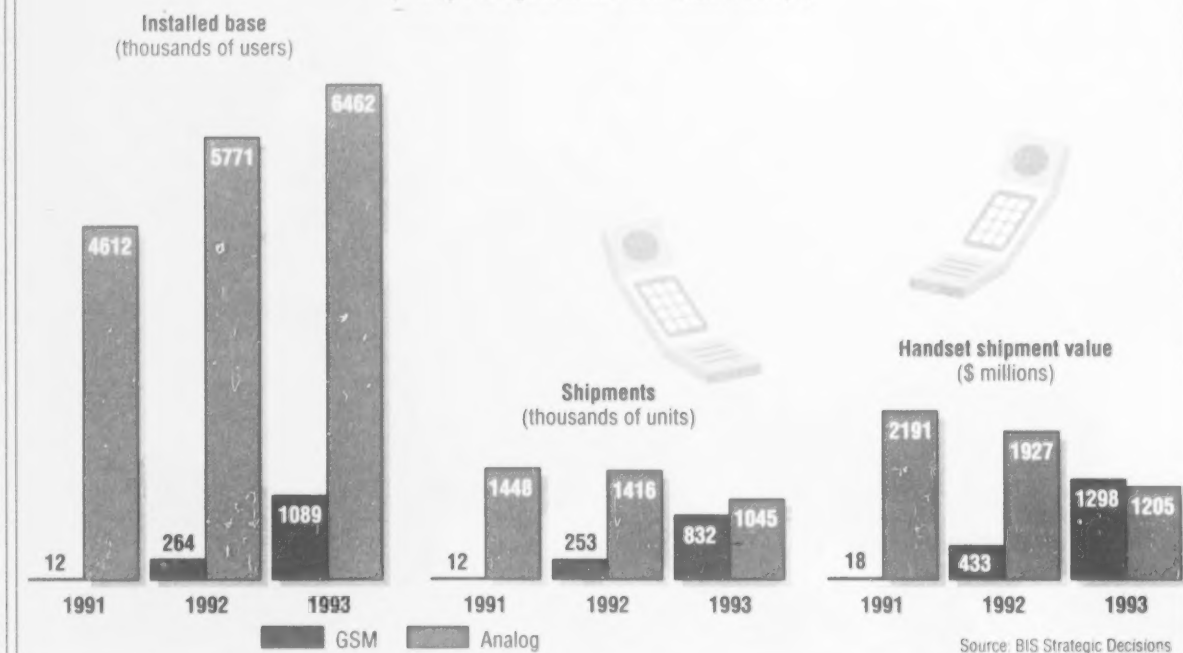
The U.S. Baby Bells—especially U.S. West, Nynex, Pacific Telesis, and Bell Atlantic Corp.—have already invested \$2 billion in cellular

infrastructures in Germany, Portugal, Britain, Czechoslovakia, and Poland, according to Systems Dynamics Ltd. in Rickmansworth, England. Spain, Italy, and Greece are also expected to award licenses to international consortia to build and run mobile networks by 1993.

Basic telecom equipment will be another growth engine in Europe for U.S. companies. By the end of 1992, the 12-nation European Community is expected to spend \$22 billion for

Cellular sounds good to Europe

(Analog and digital, Eastern and Western Europe)



public infrastructure equipment (a 1% increase over 1991) and \$5.5 billion for PBXs and faxes (a 3.3% hike), according to BIS Strategic Decisions.

OTHER MORE ADVANCED telecom products and services—digital imaging, videoconferencing, multimedia, and the wide area network transmission coding technique known as frame relay—are unlikely to arrive in Europe before the mid-1990s. One reason is that Europe lacks the high-performance, low-cost 1.5 megabit per second (Mbps) digital links that have fed the growth of such services in the U.S. Another is that, for now, bandwidth is relatively scarce and expensive in Europe.

The European cellular market, however, is no piece of cake for U.S. vendors. On the infrastructure side, entrenched European suppliers L. M. Ericsson of Sweden and Siemens AG of Germany pose powerful competition. Despite being the largest cellular-network supplier in the U.S., for example, AT&T Network Systems International has had limited success outside the U.S., except for in the Philippines and South Korea. It was only two months ago that AT&T landed a contract for half the backbone equipment for Germany's second digital cellular network, to be built by Mannesmann Mobilfunk; Ericsson Radio Systems will build the other half.

In handsets, meanwhile, Motorola is the only U.S. heavyweight in the European GSM market. (GSM is the digital European standard that is intended to unify Europe's previously fragmented analog cellular market.) BIS estimates the value of GSM phones shipped should reach \$433 million this year (up from only \$18 million last year), and \$1.3 billion in 1993. Besides Motorola, major prototype handset producers in the still-emerging market include Nokia Mobile Phones and Orbitel Communications. Matsushita is the latest entrant in the field, and industry watchers expect that, within the decade, the Japanese will have a

Telecommunications market forecast

Shipments for EC countries
(\$ millions)

	1990	1991	1992	1993
Fax	2,894	2,999	3,006	2,938
PXB	2,284	2,334	2,501	2,768

Source: BIS Strategic Decisions

dominant share of the market.

GSM is nonetheless a promising growth area—at least for U.S. telecom test equipment makers. Hewlett-Packard Co. pegs the 1992 GSM test market at \$100 million. Although HP won't give out sales figures, Roger Kann, HP's program manager for GSM testing in Amstelveen, the Netherlands, says a "significant percentage" of HP's total test sales will be in Europe, partly fueled by GSM testing. HP's competitors include Schlumberger Technologies, Racal, Marconi Instruments, and Rohde & Schwarz. Because the GSM test market is so new, however, it is impossible to nail down market share numbers.

GSM test sales could cool down yet. Manufacturers are waiting to see how the European market accepts GSM and its competing digital cellular technology, PCN, which operates at a different frequency.

AS FOR FAST-GROWING products of the near future, European integration will compel multinational companies to boost their investment in data networks and services that link far-flung operations. U.S. companies selling in Europe should offer products that support managed data networks (MDNs) and other value-added network (VAN) services. European demand for MDN services is projected to grow from \$633 million this year to \$776 million in 1993, according to Systems Dynamics. Meanwhile, data, image, voice, and videoconferencing services on VANs will generate some \$12 billion in revenue in 1995, according

to BIS Strategic Decisions, up from \$3.35 billion in 1990.

There's a caveat to the robust growth: While the VAN service market is opening in many countries, the sector remains heavily regulated, and the PTTs retain monopolies on many voice, but not data, services.

Another telecom growth area is virtual private networks, or VPNs—public networks that offer services similar to those of dedicated leased private networks, but at a lower cost. The U.S. VPN market grew 42% last year (to \$2 billion), according to the Yankee Group. European growth rates are less certain, however. The European market is less developed than the U.S. market, partly because Europe's traditionally diverse switching standards have made it impossible to offer identical VPN services in each European country.

Now a flurry of VPN activity is being driven by Europe's attempt to update its antiquated telephone services. Last year, Sprint International became the first company to attempt to change Europeans' preferences for private networks. Sprint is partnered with Britain's Cable & Wireless and the Dutch PTT, as well as non-European PTTs, to offer VPN international service in Europe with products that are identical throughout Europe, including common switch technology based on Northern Telecom equipment. AT&T is courting other PTTs to set up a rival VPN offering. It already offers interconnection to VPNs run by the PTTs in the U.K., Norway, France, Italy, and Japan.

Despite the recent deal-making in VPNs, Europeans are more receptive to MDNs (in which a network is managed by a third party) and to public network solutions that offer bandwidth on demand. Major U.S. players in the MDN services arena are GE Information Services (the dominant player), Sprint International, and AT&T Corp. Others include the international consortium Infonet and newcomers BT, Cable & Wireless, and France's Transpac. □



Electronics' new refugees find a haven in Austin

Driven out by high costs and red tape in Boston and Silicon Valley, industry execs see a lot to like in the heart of Texas

By Quang Bao

Maybe it was the helicopter ride from the airport that ended in a sun-drenched meadow of bluebonnets. Maybe it was the offer of \$20 million in private funds for research. Or maybe it was the lack of corporate and personal income taxes. Whatever the inducement was back in 1983, officials of the new Microelectronics and Computer Technology Corp. (MCC) say they had little trouble winnowing their list of more than 50 U.S. cities to pick Austin, Tex., as MCC's home. Austin's infrastructure, proximity to brain power, and quality of life "made it very hard for us to say no," says Robert Rutishauser, MCC's vice president of finance and administration.

A lot of other executives apparently agree. At last count, more than 1,137 electronics companies operate in Texas, the fourth most popular state for the electronics industry, after Massachusetts, California, and New York, according to the American Electronics Association (AEA) in Washington, D.C. The roster in Austin alone—widely considered the state's most fertile soil for growing

high-tech companies—including IBM, Motorola, 3M, Sematech,ypress Semiconductor, and Advanced Micro Devices. Indeed, total electronics employment increased 13.6% from 1987 to 1990, according to the American Electronics Association (AEA), thanks to relatively low costs and a pro-business environment.

Austin's status as a great place for the electronics industry is a relatively recent phenomenon. During the 1980s, says Rutishauser, a "disorganized" city council seemed to change the rules for electronics companies every day. "Officials got into areas where they didn't know what they were doing," such as controls

on chlorofluorocarbon use and shipping, notes John Paxton, regional manager in Dallas for the AEA, who adds that businesses were threatening to leave.

The hostile attitude of politicians toward business changed when Ann Richards moved into the governor's mansion in Austin in 1991. A longtime environmentalist, Richards had been convinced that the high-tech business would destroy the state's land, water, and air. After a lot of education by the industry, however, Richards came to realize that the electronics industry in Austin contributed to the overall financial health of the state. "Electronics was the bad frog that turned into the prince who saved the city," remarks Paxton.

Richards set out to lure businesses to Texas. She dumped Austin's anti-growth city council and slightly eased the tax burden to business. Representatives of the electronics industry, including officials from Motorola and IBM, participate in setting environmental regulations. "Once a company comes here, the city council and the community is willing to help it succeed," says Sylvia Simpson, spokesperson for

Doing business in three states

(1990 data)

	CA	TX	MA
Number of electronics companies	5,794	1,137	1,380
Number of electronics employees	566,135	164,969	183,482
Electronics employment % change ('85-'90)	-3%	8%	-12%
Electricity costs per kilowatt in cents	09	04	08
% of state funds spent on R&D	13.1%	6.4%	5.8%
Median home price	\$255,000	\$95,000	\$182,000
Per capita income (\$ thousands)	\$19,849	\$17,945	\$22,569

Source: American Electronics Association; Bureau of Labor and Statistics; state chambers of commerce; Boston Edison Electric; National Assoc. of Realtors; U.S. Department of Commerce-Bureau of Economic Dept.

REGIONAL PROFILE

Lockheed Missiles & Space Co. in Austin. "Doing business in Austin is like one-stop shopping," adds Ted Pickens, communications director for 3M. "City officials act like your next-door neighbor, and there's always a dialogue between community and government."

THE WELCOME MAT extended by city and state officials presents quite a contrast to the hostile attitudes of other high-tech areas. Consider the experience of San Jose-based Cypress Semiconductor. Its officials received VIP treatment when seeking a location for a subsidiary, Ross Technologies. Cypress CEO T. J. Rodgers recalls that he was greeted at the Austin airport by cheerleaders when he arrived for a site visit in the town of Round Rock, 12 miles from Austin. There, Rodgers received a blank building permit signed by the mayor. The town's hospitality continued after the deal was done as well. "It changed an aluminum wiring code in 48 hours," says Rodgers. "In California, it took more than a year to get approval to put up an awning to keep the rain off my employees."

The relatively low cost of doing business in Texas is another big draw for electronics companies. Not only does the average three-bedroom home in Texas cost almost half its equivalent in Massachusetts, but Austin boasts significantly lower utility rates than San Jose and Boston—4 cents per kilowatt versus 9 cents and 8 cents, respectively. Those kinds of expenses—along with high taxes, unsympathetic government officials, chronic water shortages, and heavy traffic—help explain why electronics industry employment grew 8% per year in Texas while shrinking by 3% in California and 12% in Massachusetts from 1985 to 1990.

A plentiful supply of qualified scientists and engineers also has attracted electronics companies to Texas. Every year the University of Texas, Texas A&M, Rice University, and the University of Houston pump



"You don't have to fight for people here the way you do in California," says Microelectronics and Computer Technology Corp.'s Robert Rutishauser

more than 6,000 computer scientists and engineers into the work force. "You don't have to fight for people here the way you do in California," says MCC's Rutishauser.

Austin's schools are doing more than producing bodies—they're producing bodies with the right skills for the electronics industry. "Texas universities have always placed a strong emphasis on science and

"City officials act like your neighbor—there's a dialogue between community and government"

Ted Pickens, communications director for 3M

math," contends Karen Richards, Texas Instruments' education resource manager.

Academics and industry officials cite a dynamic partnership between the schools and companies in the area as the source of much of Austin's success. "We've got some of the best people in electronics, particularly from the semiconductor industry, on our faculty," contends Ben Streetman, UT professor of engineering and di-

rector of the university's microelectronics center. "UT is anchoring Sematech and MCC research efforts, which says a lot about how industry works cooperatively with academics in Austin."

Adds TI's Richards, "the universities are more than just places to job shop—they give us a good perspective on where our market is headed and what strategies TI can use to become more competitive."

As with engineering programs elsewhere, UT's curriculum for engineers is broader than just calculus and physics. Austin's high-technology industry, in fact, actually helps shape the curriculum of engineering classes. "We're teaching statistics and communication skills, since the manufacturing industry demands more than just black-or-white thinkers," says Willis Adcock, a retired TI executive who now teaches engineering at UT.

COMMON ALSO TO state capitals is a steady flow of government-related employment, which has shielded Austin from the downturn in oil and energy prices.

Another draw for companies is Austin's policy of luring new technology companies with state research funds. The \$21 million Advanced Research Program, the \$41 million Advanced Technology Program, and the \$95 million Technology Allotment Fund are designed to match education resources with industry to create a long-range technology plan for the entire state. "We're making a very strong effort to diversify the Texas economy by investing money in our students and researchers," says Dana Chiodo, director of government affairs for Roan, Simpson & Autrey, a law firm that helped to write the legislation.

MCC and Sematech, along with Austin's low costs, cooperative politicians, strong universities, and research funds, provide a thriving high-tech climate. A host of spin-off and auxiliary companies have been created in the area during the past decade. "The expansions or reloca-

And what about the rest of Texas?

AS WITH Austin, Dallas, Houston, and San Antonio are aggressively seeking new high-technology investment to shed their traditional dependence on oil and other cyclical industries. Their relative size and weakened finances give them some advantages—Dallas, San Antonio, and Houston are among the 10 largest U.S. cities—but they suffer from some serious problems as well.

Once almost entirely tied to the petroleum cycle, metropolitan Dallas now attracts a variety of companies and industries. American Airlines, J. C. Penny, LTV, and part of GTE have arrived there during the past few years. Dallas offers free economic planning to relocating or expanding companies. In addition, the "Big D" has embarked on an ambitious program called Interlink to coordinate vocational schools' curricula and the future needs of companies.

Manufacturing has become the *raison d'être* of San Antonio. With wages running an average of 22% less than in Austin, Dallas, or Houston, a wave of production-oriented electronics companies have located there, including Sony

and Fujitsu. Despite its reputation as one of the least expensive cities to do business in, San Antonio is often overlooked by expanding businesses because of its perceived low quality of life and few cultural amenities compared with Dallas and Austin. The city's Chamber of Commerce is working to offset its modest amenities with programs to increase tourism and special efforts to lure new biotechnology companies to the region.

But Houston takes the prize as the most underrated city. The summer weather may be impossible due to the humidity, but real estate prices are cool. Buildings long abandoned by struggling oil and other energy-related companies are irresistible bargains for electronics companies looking for space—leases can be obtained for \$9 per square foot in top-quality buildings in metropolitan Houston. The city "hasn't bounced back from the natural-gas price reduction," says Barton Smith, professor of economics at the University of Houston. "If I were an electronics company, I'd move to Houston only because [of low real estate prices]," says Paxton. "Otherwise I wouldn't come." □

tions would not have happened if [MCC and Sematech] weren't here," says Angelos Angelou, vice president of the Economic Development Division for the Greater Austin Chamber of Commerce. MCC alone has spawned at least 12 companies, including Evolutionary Technologies Inc., a small company specializing in data integration software.

Numerous entrepreneurial successes have grown out of Austin, including Dell Computer Corp. and CompuAdd Inc. To encourage future entrepreneurs, the UT Graduate School of Business started the Austin Technology Incubator in 1988, matching venture capital sources and professional contacts with high-

tech start-up companies. One recent graduate of the program, Rochelle Communications Inc., has developed a caller identification device hooking the PC to the telephone.

In addition to the numerous start-ups, Austin's growing charms have attracted a host of large companies to locate or expand their operations in the area. IBM built a 1.2 million square foot addition to its existing manufacturing facility. Motorola added a \$650 million wafer fab plant to its Austin operations. Apple Computer Inc. recently announced a customer support center in Austin, which will create 400 jobs. "IBM and other companies expanding is a key sign that Austin's economy is im-

proving rapidly and coming back strong," says Daniel Van Cleve, state government programs administrator for IBM.

The influx of jobs and other upbeat signs of economic health provide a refreshing lift to life in Austin. Residents have been shielded from the unemployment problems that affected Houston and Dallas: The highest statewide unemployment rate during the 1986 oil bust was 8.9% compared with Austin's 5.6%. In fact, the gloom and doom of New England and the daily traffic hassles of San Jose seem light years away. "The Austin environment isn't deteriorating as it is in other places," says an official from the Environmental Protection Agency in Washington, D.C. The agency says that Austin's air quality was unsatisfactory for 79 days out of 1990, while San Jose's air was considered poor for most of the year—247 days.

Indeed, the style of life in Austin stems from a sense of confidence and well-being. The temperate climate offers an extended season for outdoor activities. Barbecuing and swimming in Barton Springs top Austin's activities list, because the summer is so long—grills are smoking from March to November.

However, the city may not be everyone's idea of heaven. One drawback is Austin Municipal Airport, a rather provincial facility for a city with a population of about 800,000. It offers relatively few direct flights to either coast. Consequently, flying to New York or San Francisco often becomes a two-day ordeal for local executives who usually have to first fly to Dallas or Houston before boarding a plane for either coast.

Another less tangible drawback is the common image of Texas remaining in the frontier mode. "It's hard to convince employees and companies to move here," says Tom Hillman, a human-resource consultant in Austin. "You have to do a lot of selling to push someone who is used to riding in cabs to move to a city where they think the main way to get around is by horse." □

Shakeout underway for graphics board makers

Last year industry revenue declined 13% to \$627 million, but the worst is yet to come. Can 100 vendors survive a commodity market?

By David Webb

Turmoil in the personal computer market and rapidly changing technologies are brutally shaking out the graphics board industry.

Only nimble vendors with leading-edge designs are surviving, while low-end "plain-vanilla" makers of older VGA boards are fading.

More than 100 vendors are still swimming the shrinking waters of the graphics card market, despite forecasts of declines in unit shipments and flat revenue due to intense competition and chip implementations of graphics boards. Last year worldwide graphics board revenues decreased 13%, to about \$627 million from \$721 million in 1990, according to Jon Peddie Associates in Oakland, Calif. Sales will remain at that level through 1993, but unit shipments will decline by 300,000 to 5.4 million this year and take a 22% dive next year from the shift to chip versions of VGA. The shakeout "is good news for chip companies and high-resolution board vendors," says Peddie Associates' vice president Fred Dunn. "To low-end VGA vendors, things look pretty bleak. You can always expect that in commodity markets."

Traditionally, shakeouts first claim marginal players in a market, but the consolidation of the graph-

ics board market has been so rapid that an early victim was the leading player just two years ago. Western Digital Corp. in Irvine, Calif., had 50% of the market in 1989 and had among the largest shares of the market in 1990 but completely dropped out of the market last year, largely because of intense price and margin pressures, according to Joan Carroll-Brigham, a graphics board market analyst at International Data Corp. in Framingham, Mass.; company officials declined to comment.

A host of smaller companies such as Genoa Systems Corp. in San Jose are abandoning the low-end of the

board market as demand shifts to higher performance graphics. The consolidation "won't be pretty," says Larry Liang, president of Genoa Systems. His company shifted from building unintelligent frame buffer VGA cards to microprocessor-based VGA accelerator boards.

User demand for higher performance graphics to support applications using Microsoft Inc.'s Windows environment and multimedia (full-motion video, audio, and image processing) systems set the stage for the shakeout. Enhanced color processing, higher screen resolutions, and new standards also are behind the market

shifts. Only a small pool of vendors of higher-end graphics cards and motherboard chipsets will survive, if they can move fast to remain responsive.

Among the likely survivors are current market leaders ATI Technologies Inc. in Scarborough, Ontario, and Hercules Computer Technology Inc. in Berkeley, Calif. ATI and Western Digital shared some 35% to 40% of the graphics board market in 1990, estimates Jack Roberts, director of Dataquest Inc.'s graphics and display market service in San Jose. Other leaders include Headland Technologies, Cardinal Technologies, Diamond Computer Systems, and Boca Research. Also leading to the



"Rather than buy a board from a board manufacturer, we buy the same chips they do and integrate them on our own motherboards," says Francisco Nares of AST Research

Ed Greenberg

MARKET PERSPECTIVES

shakeout is the tiny size of many suppliers—only 18 vendors had more than 1% of the market. "Those companies that are dedicated to the graphics board market will stay in there," predicts Roberts. "The low-cost board houses will disappear, and spinoffs of systems-level companies will have a hard time keeping up."

Two types of integration are roiling the market: OEMs adding graphics chipsets to their systems and board makers developing chips for the motherboard. VGA graphics capabilities once available only with

add-in boards are quickly being integrated into chipsets that some OEMs are buying and inserting on their motherboards. "Graphics has transformed itself into a strategic part of the business," says Francisco Nares, product marketing manager for CAD systems at AST Research Inc. in Irvine, Calif. "Rather than buy a board from a board manufacturer, we buy the same chips they do and integrate them on our own motherboards." AST's move to integrate VGA chips onto its motherboards also frees a slot on the I/O bus.

Rather than be cut out of the market, some board makers are selling their own single-chip implementations of basic VGA graphics capability. "It's gotten cheaper to make a single chip than an add-on board, and people are demanding the speed you can get with 33 Megahertz on the CPU bus versus 8 MHz on the AT [I/O] bus," notes Shubha Tuljapurkar, vice president of marketing of Headland Technology in Fremont, Calif. Graphics chips that are on the motherboard with its high-speed CPU bus increase the

IBM's days as a graphics standards setter may be over

IBM UNVEILED a passel of multimedia personal computers dubbed "Ultimedia" at Comdex in October but glossed over its next-generation graphics processing architecture, extended graphics array (XGA). That may be an indication that IBM realizes its clout in graphics board architecture and standards is waning, though XGA is expected to ultimately join VGA as a leading graphics standard by 1994.

XGA is a microprocessor-based graphics board architecture. Unlike VGA, which is really a resolution definition, XGA has what San Jose-based Dataquest Inc. analyst Jack Roberts refers to as "true graphics coprocessing capability." Essentially, it incorporates line drawing and bit-block transfer functions into a board-based MPU, relieving the system CPU of those processing functions, and thus allowing faster graphics-processing performance. Line drawing, or refresh, is important in video and complicated design graphics applications. The speed of bit-block transfers is important because the faster they can be performed, the quicker users can jump from window to window of graphics in Windows.

IBM announced XGA in 1990 and licensed SGS-Thomson's Inmos subsidiary to manufacture XGA chips for the merchant market last year.

IBM itself has only recently begun to ship XGA chips with Micro Channel bus Model PS/2s. Merchant graphics board vendors aren't expected to jump to build boards around the Inmos chips right away, but analysts expect that over time they will.

The key to XGA's market acceptance—Microsoft Corp.'s Windows environment—also happens to be the reason IBM will lose leadership of future graphics architectural standards. Scores of Windows-based graphics application software packages are being developed for personal computers, and those computers need the power provided by MPU-based accelerator boards and chipsets. Windows users' need for speed is propelling demand for better graphics processing performance to unprecedented levels, not XGA's features themselves. The next-generation graphics market "is really the Windows acceleration market, not XGA," says International Data Corp. analyst Joan Carroll-Brigham. "XGA really doesn't define the market the way VGA did. Windows does more to define the market than XGA or IBM." Adds Francisco Nares, a product marketing manager at AST Research Inc., "Windows is really the standard that everybody will run to [accommodate]; we've seen you can

almost ignore IBM."

IBM's graphics standards hegemony is also at risk because XGA is viewed as a weak standard. Although it has an on-board MPU, XGA doesn't provide what Genoa's Liang calls "true color:" 24-bit channels supporting 16 million colors. IBM is working on 16-bit XGA for support of 64,000 colors. In contrast, 8-bit Super VGA only supports 256 colors using 1024-pixel by 768-pixel screen resolution. There's enough performance growth potential in the VGA architecture to allow it to outperform XGA as it stands now, contends John Edeleanu, president of Berkeley, Calif.-based Hercules Computer Technology Inc. As long as Windows users are happy with upgraded VGA, they couldn't care less about the architecture short of a significant price differential. XGA is more expensive, as one would expect.

Nevertheless, IDC's Carroll-Brigham and others say there's enough reverse-engineering and XGA development work going on to conclude that XGA—or a form of it—will be a viable contender as the next generation graphics standard. "XGA is important because it's IBM," explains AST's Nares, "but the fact that IBM stated XGA as a standard doesn't mean it will be one." □

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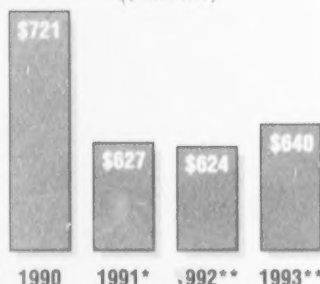
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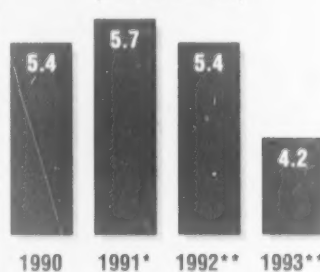
Graphics board revenue outlook is flat...

(\$ millions)



...while unit shipment levels plummet

(units in millions)



* Estimated ** Projected

Source: Jon Peddie Associates

speed of Windows applications by a factor of up to 10.

The integration trend is not new, but the speed of conversion is having a profound effect on the nature of the graphics hardware market. However, analysts predict that the motherboard chipset market is approaching saturation with recent introductions of VGA-on-a-chip implementations by Cirrus Logic Inc. following chipset entries by Texas Instruments, National Semiconductor, Advanced Micro Devices, and others. "One has to ask how long that [migration to motherboard] window will be open," wonders Dunn.

Graphics board and chip vendors are also discovering that with higher levels of integration, cheap chip-level solutions make the OEM channel more attractive than the conventional end-user retail and value-added reseller channels. "VARs are definitely being squeezed out," says Rob Rykf, Northgate computer's vice president of R&D. "We ship nearly 100% of our units configured with video."

Some board-level graphics vendors discount the extent of the OEM's interest in including graphics boards in their systems. "OEMs don't like to get stuck when the technology moves so fast," insists Genoa's Liang, despite moves by AST, Northgate, and other OEMs to bundle high-end video into their

systems. However, other board vendors formerly dependent on dealers and other retail channels see the OEMs as customers, not competitors. Headland, for example, views the OEM market as a growing channel that may one day exceed the retail channels.

Prospects for vendors of high-end products are brighter, although fast-paced. In the past two years, users were faced with four resolution enhancements: VGA, enhanced VGA, Super VGA, and XGA. "You can't be in this business and not expect to move fast," says John Ede-

leanu, Hercules' president.

IBM's extended graphics array (XGA) is the latest-generation standard for graphics architectures. It emerged as an industry standard with IBM's announcement of XGA chip availability in mid-1991 (see "IBM's PC graphics standard-setting days may be over," page XX). Unlike VGA, XGA incorporates a dedicated graphics coprocessor, but industry officials are critical of its limited support for color, modest refresh rates, and other weaknesses.

Hercules and Genoa insist that they can beat XGA's color and resolution performance with software instead of an on-board MPU. "There are extensions to VGA that can beat XGA's performance, hands down," says Hercules's Edeleanu. "We don't see any reason to jump in [with XGA products] right away." □